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RELATIONSHIPS AND VARIATION IN THE GARTER SNAKES, GENUS, *THAMNOPHIS* OF THE PUGET SOUND REGION OF WASHINGTON STATE*

By William B. Hebard

The garter snakes, genus *Thamnophis*, which inhabit the Puget Sound region of Washington have long been the subject of much taxonomic controversy. Fitch (1940, 1941) has made an extensive study of geographic variation of Pacific Coast garter snakes. Recent taxonomic revisions, Fox (1948), Fitch (1948) and Johnson (1947) have clarified the relationships of the various endemic forms thus indicating that the *Thamnophis* complex of the Puget Sound region is composed of members of the following three species group: The monotypic species *ordinoides*, which exhibits minor geographic variations; the *vagrans* subspecies of the wide-ranging species *elegans;* and the three subspecies *concinnus*, *pickeringii* and *tetrataenia* which are members of the complex species *sirtalis*.

A homogeneous series of 533 specimens collected during the summer of 1948 in King County, Washington, provided an opportunity for further statistical investigation of individual and species variation in this region. Only newborn juveniles and sexually mature adults were used in this study. An insufficient number of adolescent specimens were available to provide an accurate picture of all age groups for all three specimens. The data on the newborn juveniles was obtained from a series of broods born by females within a day or two of capture. These broods were considered to be similar to broods born in the natural environment and not to have been affected by the very short period of confinement of the gravid female in a terrarium.

Thamnophis ordinoides is the smallest of the species of garter snakes inhabiting the Puget Sound region. The largest male specimen (U.W.#1320) had a total length of 605 mm. while the largest female (U.W.#1380) had a total length of 745 mm. The data compiled in Table I shows that the juvenile and adult females had mean body lengths of 126.40 mm. and 447.20 respectively, whereas in the juvenile and adult males the mean body lengths were 127.60 mm. and 358.60 mm.

TABLE I

SUMMARY OF BODY DIMENSION STATISTICS

T. ORDINOIDES, KING COUNTY SERIES

Juveniles (At birth)	No.	Range mm.	Mean mm.	s	V%	ratio TL/BL
Males						
Body length	38	119-137	127.60 ± .74	4.54	3.56%	.301
Tail length	38	33-43	38.53 ± .36	2.27	5.89	
Females						
Body length	34	115-135	126.40 ± .83	4.84	3.83	.283
Tail length	34	31-44	35.82 ± .45	2.59	7.22	
Adults (Sexually mature)						
Males						
Body length	100	293-461	358.60 ± 4.12	41.20	11.50	.330
Tail length	100	95-144	122.15 ± 1.29	12.85	10.51	
Females						
Body length	93	348-557	447.20 ± 5.01	48.20	10.80	.288
Tail length	91	102-160	112.58 ± 1.43	13.60	12.09	

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Of the three species inhabiting the Puget Sound region of Washington *T. e. vagrans* is intermediate in size. The largest male specimen (U.W.#1348) had a total length of 650 mm. while the largest female specimen (U.W.#1857) had a total length of 920 mm. The statistics relating to body length and tail length of the males was 143.10 for the juveniles and 431.80 mm. for the adults while the female mean body length was 144.58 mm. for the juveniles and 517.60 for the adults.

TABLE II

SUMMARY OF BODY DIMENSION STATISTICS

T. E. VAGRANS, KING COUNTY SERIES

Juveniles (At birth)	No.	Range mm.	Mean mm.	s	V%	Ratio TL/BL
Males						
Body length	32	125-160	143.10 ± 1.68	9.56	6.68	
Tail length	30	42-53	48.60 ± 0.53	2.91	5.99	.342
Females						
Body length	49	128-165	144.58 ± 1.33	9.36	6.48	
Tail length	48	40-50	44.21 ± .38	2.64	5.98	.307

Adults (Sexually mature)						
Males						
Body length	22	380-510	431.80 ± 7.64	35.80	8.30	
Tail length	22	130-170	146.54 ± 2.30	10.75	7.34	.341
Females						
Body length	44	460-615	517.60 ± 6.17	40.80	7.90	
Tail length	44	128-178	148.60 ± 1.83	12.10	8.15	.288

The largest of the species of garter snakes inhabiting the Puget Sound region is *Thamnophis sirtalis*. The largest female specimen (U.W.#1514) was 1037 mm. long while the largest male (U.W.#1429) had a total length of 727 mm. Both of these specimens were collected along the shore of Lake Washington near Kenmore, King County. This population consists mainly of melanistic forms belonging to the subspecies *pickeringii*. The body dimensions are summarized in Table III. The mean body length of the males was 159.58 mm. for the juveniles and 542.80 mm. for the adults. The juvenile and adult females had mean body lengths of 158.56 mm. and 584.40 mm., respectively.

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TABLE III

SUMMARY OF BODY DIMENSION STATISTICS, *T. SIRTALIS*, KING COUNTY SERIES

Juveniles (At birth)	No.	Range mm.	Mean mm.	s	V%	Ratio TL/BL
Males						
Body length	32	151-170	159.58 ± 0.91	5.14	3.22	
Tail length	32	47-58	53.69 ± 0.47	2.64	4.92	.333
Females						
Body length	36	148-166	158.56 ± 0.83	4.98	3.14	
Tail length	36	46-55	50.95 ± 0.53	3.18	6.25	.320
Adults (Sexually mature)						
Males						
Body length	21	387-539	471.40 ± 10.84	49.60	10.52	
Tail length	21	144-188	157.95 ± 2.68	12.30	7.78	.338
Females						
Body length	32	473-740	584.40 ± 13.10	74.00	12.68	
Tail length	32	144-215	176.20 ± 3.54	20.00	11.34	.302

The extent of sexual dimorphism displayed by these three species of garter snakes has been compiled in Table IV. The coefficient of divergence (Klauber, 1943) expressed as a percentage (CD%) has been used to evaluate the sexual differences in scutellation as well as body and tail-lengths of adult specimens.

TABLE IV

EXTENT OF SEXUAL DIVERGENCE IN HOMOGENEOUS SERIES OF KING COUNTY ADULT GARTER SNAKES

Character	Species	Mean (males)	Mean (females)	Diff. (d)	Signif. Diff. (6d)	CD%
Gastrosteges						
	T. ordinoides	148.77±0.27	146.95±0.22	1.82	5.24	1.23%
	T. e. vagrans	168.13±0.33	161.55±0.89	6.58	6.95	3.99
	T. sirtalis	165.65±0.24	160.49±0.24	5.16	15.21	3.16
Urosteges						
	T. ordinoides	66.68±0.26	59.65±0.24	5.03	14.25	3.82
	T. e. vagrans	82.55±0.58	70.65±0.49	11.90	15.69	15.53
	T. sirtalis	82.62±0.74	74.60±0.40	8.02	9.55	10.20
Body length, mm.						
	T. ordinoides	358.60±4.12	447.20±5.01	88.60	13.70	-22.10*
	T. e. vagrans	431.80±7.64	517.60±6.17	85.80	8.75	-18.20
	T. sirtalis	471.40±10.84	584.40±13.10	113.00	17.02	-21.47
Tail length, mm.						
	T. ordinoides	122.15±1.29	112.58±1.43	9.57	4.98	8.18
	T. e. vagrans	146.54±2.30	148.60±1.83	2.06	.70	- 1.39
	T. sirtalis	157.95±2.68	176.20±3.54	18.25	4.13	-10.90

*Negative values indicate females exceed males.

LITERATURE CITED

Fitch, Henry S. 1940 A Biogeographical Study of the *Ordinoides* Artenkreis of Garter Snakes (Genus *Thamnophis*). Univ. Calif. Publ. Zool., 44:1-150

1941 Geographic Variation in Garter Snakes of the species *Thamnophis sirtalis* in the Pacific Coast Region of North America. Amer. Midl. Nat., 26:570-592

1948 Further remarks concerning *T. ordinoides* and relatives. Copeia 1948, No. 2:121-126

Fox, Wade 1948 Relationships of the Garter Snake, *Thamnophis ordinoides*. Copeia, 1948, No. 2:113-120

Johnson, Murray L. 1947 The status of the *elegans* subspecies of *Thamnophis* with description of a new subspecies from Washington State. Herpetologica 3:159-165

Klauber, L. M. 1943 Tail-length differences in snakes with notes on sexual dimorphism and the coefficient of divergence. Bull. Zool. Soc. San Diego, No. 18:1-60

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FURTHER DISCUSSION OF HEAD BOBBING IN SNAKES:- Recently Neill (1949, Herpetologica, v. 5 (6):114) has discussed head bobbing in snakes and considers it to be a widespread and infrequently mentioned characteristic. I feel that the term "head bobbing" is unfortunate because it is not analogous to the phenomenon referred to as head bobbing in lizards. Neill mentions a number of situations which often stimulate the bobbing reaction, such as mating preliminaries, addition of new specimens to a cage, crawling of one snake over the body of another, observation of movement, and pounding on the floor of the cage, and concludes that the reaction is a response to definite stimuli connected with *courtship* and *recognition of individuals*.

Quick and relatively short movements of several sorts, in addition to bobbing, occur frequently among snakes. Among them may be mentioned the short jerky movements of the head of many males during courtship as they "caress" the back of the female with their chins; also quick jerky movements of almost any part of the body may occur during the courtship of many species. Movements of this latter kind are mentioned by Mansueti (1946, Herpetologica, v. 3 (3):98) and referred to by Neill as "something of this sort" (i.e. something like bobbing).

The strike itself of a snake may be mentioned as another type of quick movement that serpents habitually use.

In addition to the situations specifically mentioned by Neill, others which give rise to movements closely related to or identical with bobbing may be cited. A hand placed in front of a snake's head and brought slowly toward the head will often induce typical bobbing. Such was the case with a number of freshly caught specimens in the writer's collection at various times, a large specimen of *Elaphe o. obsoleta* being remembered particularly well.

In confirmation of Neills statement, I have observed that snakes pursuing prey, particularly in small cages where changes in direction are frequent, often display quick head movements in various directions. This is well illustrated by garter snakes as they pursue frogs or by specimens of *Storeria dekayi* as they seek to grasp wriggling worms. Once when a northern copperhead was pursuing a mouse in a small cage the writer observed that often when the mouse turned suddenly toward the snake, the copperhead would jerk its head back several times in bobbing fashion.

These are all well-known and common observations mentioned only to indicate the diversity of the expression of perhaps fundamentally a single characteristic. Of course, the strike of a snake is a more remotely related phenomenon as are possibly the examples cited from the mating behavior of snakes, although true bobbing (as defined by Neill but deleting his reference to the observations of Mansueti) also often occurs previous to mating.

It seems to me that neither true bobbing nor any other related action cited previously can be considered the product of definite stimuli, nor limited specifically to mating or recognition behavior as suggested by Neill. The motives are, as indicated above, more general. I believe that all movements of this general character occur when snakes are in a state of nervous attention. It seems to me that bobbing movements of the head, rather than being unique in themselves, are but one type of nervous manifestations perhaps dependent on the peculiar shape of the snake's body, which may make such movements highly efficient in aiding observations.

Snakes are generally considered to be highly nervous reptiles and this nervousness might conceivably be increased by any of the bobbing situations cited; the animals are certainly maximally attentive at such times. With increased temperatures snakes become more active and nervous and thus observations such as Neill's, that bobbing "was most frequently exhibited by specimens in cages that were exposed to direct sunlight", are to be expected.

--George D. Stewart, 194 Rockland Road, Pearl River, New York

THE FOOD OF THE GILA MONSTER*

By Herbert L. Stahnke

The food of the Gila Monster has been a topic of considerable debate. A popular summarizing statement that deserves comment is made by Ditmars.

> "Some people think the food consists of ants, others assert that reptiles feed upon the eggs of birds and reptiles. Certainly it is that in captivity the Gila Monsters show a liking for the eggs of fowl and reptiles and will also take small rodents. It appears indifferent to insects and their larvae. If given an entire egg they will break a hole through one end of the shell and lap out its contents. The small soft shelled eggs of lizards and the smaller snakes are taken whole."

While keeping Gila Monsters in captivity we have found that the animal will remain in a more healthful condition if fed the entire egg with meat scraps. The whole egg is dropped into a Waring blender together with small meat scraps. As a result a very well homogenized mass of egg, shell, and meat is obtained. We cut the cost of maintaining these lizards by using infertile eggs from a nearby hatchery. Giving whole eggs to these animals is a wasteful practice. Contrary to Ditmars' statement the Gila Monster does not "break a hole through one end of the shell and lap out its contents." Usually the process is more of a clumsy crushing of the shell with the resulting flow of its contents over the surface.

Over-fed Gilas, or those sickly, will pay no attention to food placed in their pens. Animals kept in poorly lighted pens, likewise, will not feed readily. If a low-wattage electric light, however, is kept in the cage, especially during the winter season, these animals will feed regularly. An animal that refuses to feed can frequently be pulled through such a hunger strike by force feeding. This can be done by means of a catheter tube pushed down the esophagus and the homogenized fluid forced in slowly with a syringe.

The Gila Monster will eat eggs that contain small or large embryos. Whether the developing chick is dead or alive does not seem to be important. In fact, eggs that have failed to hatch in our incubators have been fed to Gila Monsters. Some of these eggs have contained nearly full term embryos.

Mr. Evans, owner and operator of the Reptile Garden just out of Phoenix, Arizona, stated that in thirty years experience as a taxidermist he had examined many stomach contents of Gila Monsters. The majority had quail or some other ground nesting bird's eggs as food. In some cases the smaller eggs had been

swallowed whole. Mr. Evans also observed the very young of chipmunks and rabbits in the stomach contents. Part of these observations were substantiated in our laboratory when a Gila Monster passed as feces two shriveled eggs that were approximately the size of quail eggs. They may have been desert tortoise eggs but the shell was completely dissolved in certain areas. The egg membrane was also intact so that the egg could be expanded by the injection of water with a syringe and needle. On the other hand, only a small amount of water entered the egg as a result of soaking in water.

We have had no positive evidence that the Gila Monster will eat either the larval or adult of insects. Nor have we observed this lizard eating any form of plant life as is occasionally claimed by some popular writers. The other item of food referred to by Ditmars, namely small mammals, is now fairly well established.

Hensley (1949) reports the regurgitation of nestling Arizona cottontails by recently caged Gila Monsters. The age of these rabbits was estimated to be 10-14 days. In this same account he reports an eye-witness account of a Heloderma regurgitating a young nestling cottontail while being attached by a dog. Photographic evidence is furnished, herewith, by Ranger William Supernaugh of the Organ Pipe National Monument.

In this same article, Hensley reports a communication from Dr. Hobart M. Smith in which he tells of a captive Heloderma consuming a house mouse, *Mus musculus*, that was offered it. Our experience in this respect has still been negative even though we constantly maintain a fair sized group of these lizards.

In connection with recent research work (Maarsingh, 1950) a live baby rabbit was offered to some of our lizards that had not been fed for approximately three months. The young animal was placed in the cage about 4 p.m. on January 18th. It was apparently ignored at the time but on the morning of the 19th the rabbit had disappeared. On January 23, a four day old rabbit, approximately three inches long, was placed in the Gila cage on a handkerchief. At 2:40 p.m. one of the smaller Gilas moved over to the newcomer and nuzzled it through its cloth cover. Then it spent several minutes of trial and error attempts to get directly to its quarry but finally contented itself with biting through the cloth into the rabbit's abdomen and hind legs. Now several more minutes were spent in trying to pull away or dig into the barrier until by mere chance a rent in the old handkerchief was found. After more clumsy maneuvering the rabbit was finally pulled free of the inhibiting cloth. Further nuzzling now followed, as if to make sure of the object, and then it grasped the rabbit around the abdomen firmly and held on for several seconds. Each time it was bitten the rabbit squealed but there was very little bleeding at the site of the bites and no discoloration beyond a slight redness. During the biting acts, there were none of the characteristic bulldog actions of tenacity nor the side to side movement of the jaws found in irritated Gilas. The bite was not vicious but

consisted of merely taking a prolonged, firm hold of the rabbit's midsection. After a short waiting period it would leisurely let go. At 2:50 p.m. the Gila, starting at the head end, began to swallow the rabbit whole in spite of the fact that it squirmed considerably. In order to initiate and facilitate the swallowing act, a slight pulling and pushing motion was exerted on the rabbit. Objects in the cage, such as the food pan and other Gila Monsters, as well as the wall of the cage were used as props. This action was continued until the rabbit head and pectoral girdle were well into the mouth and throat of the lizard. Now the Gila raised up high on its front legs, holding its head even higher, while accomplishing characteristic reptilian swallowing motions. As long as part of the rabbit extended from the mouth the Gila would occasionally lower its head in order to push the rabbit against some object and thus assist the swallowing procedure. After each of these periods the head again would be upraised into the position so characteristic of the Gila Monster when swallowing the fluid portion of eggs.

At 3:00 p.m., a lapse of approximately 25 minutes, the hind legs of the rabbit disappeared from view. Once the rabbit was completely inside of the Gila Monster an undulating motion took place in the main trunk of the lizard while strong peristaltic action was visable on the throat.

The Gila Monster was only 42 cms. long but from outward appearance one would not have suspected that it had eaten so large an animal. Shortly after the rabbit was eaten, the lizard passed fecal matter of a whitish and greenish color containing small rabbit hairs. It was not the characteristic orange color of a Gila fed only chicken eggs. From this evidence it was deducted that this Gila Monster also ate the first baby rabbit offered to the group.

This new evidence, we believe, helps to establish more firmly the idea that in nature the Gila Monster is a robber of nests. It will eat either eggs or nestlings too young to escape. It is hard to believe that an animal which usually responds as slowly as the Gila could capture a quick moving adult rodent. In the act of robbing the nest of a mouse we can conceive of it taking an adult that could not get away and that it more or less accidently caught.

Since nests are relatively scarce in this lizard's natural habitat, the entire contents are devoured and the reserve food stored in the sides of its tail. The well fed Gila Monster has a fat, spindle-shaped tail, while a specimen at the point of starvation has a relatively slender, bony-looking tail.

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LITERATURE CITED

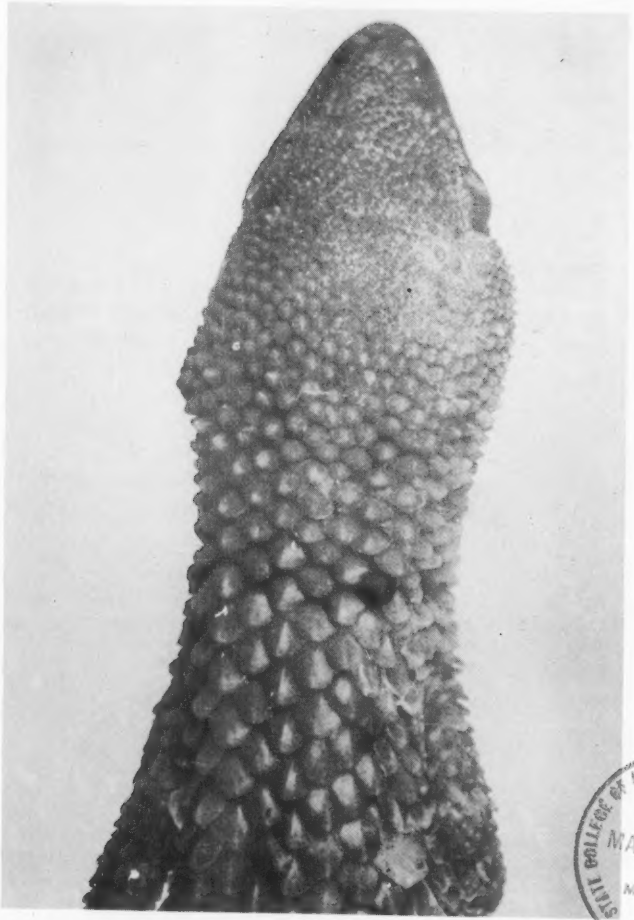
Ditmars, Raymond L., Reptiles of North America, Doubleday and Doran Company:162.

Hensley, M. Max 1949 Mammal Diet of *Heloderma*, Herpetologica 5:152.

Maarsingh, Wallace E. 1950 The effect of certain environmental stimuli on the coat color of the Gila Monster. Masters thesis, Arizona State College, Tempe, Arizona.

--Poisonous Animals Research Laboratory, Arizona State College,

*Read at meeting of the Southwestern Division of the A.A.A.S., Flagstaff, Arizona, May 1950.



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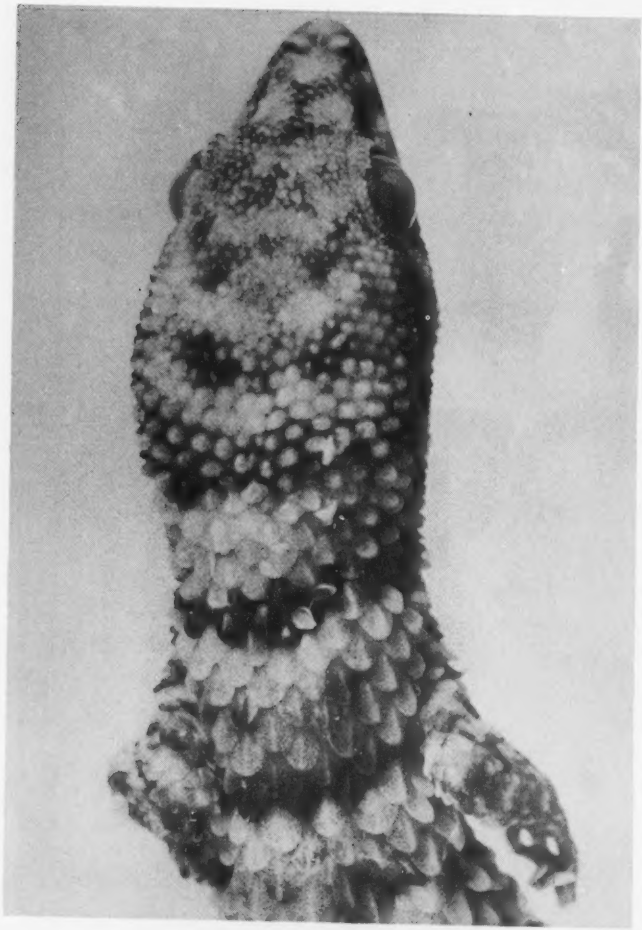
Sphaerodactylus parkeri Grant

Patternless male. Note relatively enormous scales. Original description, Copeia, 1939 :7-13



Sphaerodactylus parkeri Grant

Patterned female. From beach near Alligator Pond, Jamaica.

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